Strategy Research Project

# OPERATIONAL ENERGY METRICS: INCREASING FLEXIBILITY WHILE REDUCING VULNERABILITY

BY


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# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



**1. REPORT DATE** *(DD-MM-YYYY)*
18-03-2010

**2. REPORT TYPE**
Strategy Research Project

**3. DATES COVERED** *(From - To)*

**4. TITLE AND SUBTITLE**

Operational Energy Metrics: Increasing Flexibility While Reducing Vulnerability

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**

Lieutenant Colonel Scott D. Baer

**5d. PROJECT NUMBER**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

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Department of Distance Education

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
U.S. Army War College
122 Forbes Avenue
Carlisle, PA 17013

**10. SPONSOR/MONITOR'S ACRONYM(S)**

**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

**12. DISTRIBUTION / AVAILABILITY STATEMENT**
Distribution A: Unlimited

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**
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Properly applied, operational-energy metrics can increase operational flexibility for the Joint Force Commander. Operational-energy metrics are sufficiently mature for the Chairman of the Joint Chiefs of Staff to mandate their use as a key performance parameter for all acquisition programs and new increments of fuel-consuming systems. "Big A" acquisition provides the Department the prospect of seizing the opportunity to reset equipment more efficiently, shift a portion of the logistics tail to increase combat force structure, and improve force effectiveness.

**15. SUBJECT TERMS**
Fuel, Energy Efficiency, Key Performance Parameter, Fully Burdened Cost Of Fuel, Acquisition

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| **a. REPORT** UNCLASSIFED | **b. ABSTRACT** UNCLASSIFED | **c. THIS PAGE** UNCLASSIFED | UNLIMITED | 32 | **19b. TELEPHONE NUMBER** *(include area code)* |

USAWC STRATEGY RESEARCH PROJECT

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## ABSTRACT

AUTHOR: Lieutenant Colonel Scott D. Baer

TITLE: Operational Energy Metrics: Increasing Flexibility While Reducing Vulnerability

FORMAT: Strategy Research Project

DATE: 18 March 2010 WORD COUNT: 6,595 PAGES: 32

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CLASSIFICATION: Unclassified

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OPERATIONAL ENERGY METRICS: INCREASING FLEXIBILITY WHILE REDUCING VULNERABILITY

> Our in-theater fuel demand has the potential to constrain our operational flexibility and increase the vulnerability of our forces. Thus your Armed Forces continue to seek innovative ways to enhance operational effectiveness by reducing total force energy demands. We are also looking to improve energy security by institutionalizing energy considerations in our business processes, establishing energy efficiency and sustainability metrics, and increasing the availability of alternative sources.[1]
>
> — Admiral Michael G. Mullen, USN
> Chairman of the Joint Chiefs of Staff

The single, largest consumer of energy in the world, public or private, is the U.S. Department of Defense (DoD); supporting a “long-standing irony of fueling our defense establishment from a system that threatens our nation’s security.”[2] The Government Accountability Office (GAO) reports the Department of Defense consumes, on average, 68 million gallons of fuel to support U.S. forces in Iraq and Afghanistan each month.[3] To put 68 million gallons of fuel into perspective, the Joint Force Commander (JFC) must secure and convoy the equivalent of 8,500 fuel tankers with 8,000-gallon capacity[4] (Figure 1) monthly to operational bases in theater[5] to support both base- and combat-


Figure 1. A typical Kellogg Brown & Root 8,000-gallon tanker

operations. These fuel convoys divert forces from combat operations, reducing the JFC's flexibility and increasing operational risk.

Properly applied, operational-energy metrics can increase operational flexibility for the joint force commander. Operational-energy metrics are sufficiently mature to mandate their use as a key performance parameter for new acquisition programs and new increments of fuel-consuming systems. This paper investigates the fully burdened cost of fuel as it relates to the procurement of warfighting systems. Areas of specific inspection include reducing theater fuel transportation requirements to forward-operating bases; reducing fuel needs with more efficient living and work environments; adding energy-efficiency key performance parameter requirements for DoD warfighting acquisitions; assessing the potential influence on operational effectiveness and force structure; and examining the second- and third-order effects across the three DoD Decision Support Systems--requirements, budget, and acquisition--colloquially referred to as the "Big A."

Fuel Demand

According to congressional testimony by Chris Dipetto, Office of the Deputy Under Secretary of Defense (Acquisition & Technology), historically the Department views energy as a cheap and limitless commodity delivered by professional logisticians using air- and ground-tankers or oilers at sea.[6] The most recent spike in oil prices, as well as those in the 1970s and 1980s, highlights the risk associated with oil-supply chains. The Honorable John Young testified before Congress that for every $10-per-barrel increase in the cost of oil, DoD operating costs increase by $1.3 billion.[7] Reduced energy consumption improves national security by reducing dependence on potentially unreliable suppliers. DoD has demonstrated the ability to monitor and manage energy

requirements on installations and now is the time to pursue investing in the energy efficiency of the operational force.

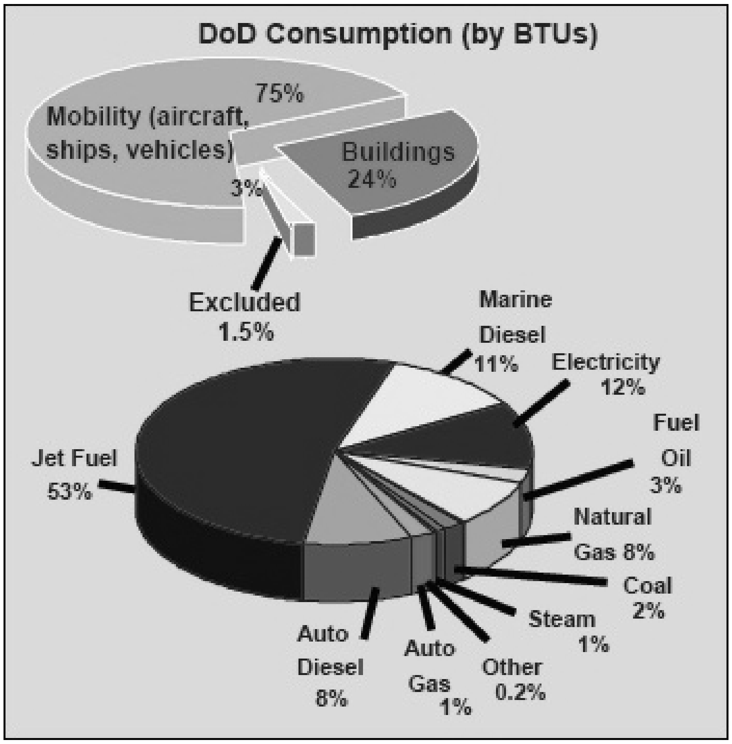


Figure 2. DoD FY07 Energy Consumption

Over seventy-percent of the tonnage convoys transport in Iraq and Afghanistan is to supply fuel to forward-operating bases.[8] Air Force jets and Army and Marine Corps combat vehicles consume considerable amounts of fuel, but the largest battlefield consumer of fuel is the generator. Generators provide power for everything from heating and cooling for living and work environments, to power for data centers and medical operations. A 2008 Defense Science Board Task Force report explains that during peacetime operations, generators consume twenty-six million gallons of fuel annually, whereas generators are consuming 357 million gallons of fuel annually during current overseas contingency operations.[9] Generators account for forty-four-percent of the fuel delivered to forward-deployed locations (or 3,906 fuel trucks a month) to support base

operations. During peacetime operations, aircraft consume half of DoD's energy requirements followed next by ships. Initial emphasis in DoD is focusing on power efficiency and, to a lesser extent, on-site production at forward-deployed locations.

Base Operations

Reducing fuel requirements at forward-deployed locations will reduce lines of communication, resulting in increased operational flexibility and security for the JFC. Even though eight years have passed since the Defense Science Board Task Force recommendations, there has been little, top-down, institutional interest in reducing the billions spent to deliver energy; though some bottom-up service initiatives seem to be embracing energy efficiency.[10] There is likely no single solution to reduce fuel consumption of weapons systems but addressing the biggest consumers looks like an appropriate place to begin.

As noted above, generators are the largest consumer of fuel on the battlefield, providing power to critical communication equipment and climate control to living and work environments. Tents and containerized structures make up the preponderance of these living and work environments at forward-deployed locations. One can readily imagine that heating a tent in Afghanistan during the winter or cooling a tent in the Iraqi desert in the summer is an energy intensive task. "In July 2007, the Power Surety Task Force and U.S. Army's Rapid Equipping Force demonstrated a technique for insulating temporary structures such as tents and containerized living units using an exterior application of spray foam"[11] (Figure 3). The pilot program provided positive results at reducing heat and cold as well as noise and dust in the structures. DoD and U.S. Central Command (CENTCOM) pursued a larger-scale foam-insulation operation in both Iraq and Afghanistan in an attempt to reduce the number of generators required to

Figure 3. Tent Before and After Application of Foam Insulation

power the environmental control units (ECUs) for these structures.[12] According to a GAO report, the tent-foaming project could reduce fuel consumption for temporary structures by half;[13] and according to testimony by Alan Shaffer, tent insulation in Iraq alone will save between thirteen and twenty-six truckloads of fuel delivered daily to forward-operating bases.[14] With half of the casualties in theater coming from convoys,[15] a small investment in foam has the potential to save lives, increase operational flexibility, and reduce cost.

Insulated structures reduce power requirements by half but, according to Project Manager-Mobile Electric Power, many of DoD's power generation units have been in operation for thirty years, or twice their original life expectancy.[16] The Program Manager's replacement generators, the Advanced Medium Mobile Power Sources, will achieve an efficiency gain of fifteen- to twenty-five-percent according to the 2002 Oak Ridge National Laboratory development of concept report.[17] Moreover, this year the Program Manager intends on replacing its legacy environmental control units with improved units to provide heating, cooling, and dehumidification. These new units will consume twenty-five-percent less power than their predecessors.[18]

As the result of a request by Major General Richard Zilmer, the 2006 Commander of Multi-National Force – West in Iraq, to reduce his Marines' exposure while delivering fuel to power generators, the Transportable Hybrid Electric Power Stations (THEPS) was fielded. The THEPS provided a significant fuel savings but the system did not meet its operational requirements. However, the offshoot of this endeavor produced the Hybrid Intelligent Power (Hi-Power) program.[19] The HI-Power program is a near-term effort to develop and validate a tactical intelligent-power-management incorporating multiple power sources (including the use of renewable energy sources where applicable), energy storage technologies, power distribution, and demand management.[20] This program has the potential to achieve an additional gain of forty percent in energy efficiency over current methods. Even more impressive is the program's ability to manage power distribution, bringing disparate power sources together to operate at greater efficiencies. This means that instead of some generators running at twenty-five percent capacity and others at eighty percent, generator loads will be varied to run generators at optimum output to improve efficiency of energy consumed.

Information technology (IT) resources are significant consumers of power on today's battlefield. Usually one of the first tents erected or structures acquired on a new forward-operating base is to house radios and servers to enable command and control. This equipment requires environmental control in that most IT equipment is commercial-off-the-shelf (COTS) equipment. Roughly seventy-percent of the power COTS servers consume is to operate power supplies, fans, and memory; with the remaining thirty percent to process data into usable information. In addition to the environmental control

and power generation already covered, when looking to IT, the Department should procure smart power supplies. These are nothing more than power supplies that vary their power output, much the way the Project Manager-Mobile Electric Power improved its generators, and computer power supplies can do the same. Implementing smart power supplies in server rooms at forward-operating locations will reduce server power requirements an additional fifteen percent.

Looking to the future, the land-based services are developing renewable and alternative energy-technology initiatives to generate power at forward-operating locations to reduce forward-operating-base fuel demand. There are mobile generators with solar panels, wind turbines, and storage batteries; a concrete dome living environment powered by solar panels and windmills; and a tactical garbage-to-energy refinery to convert paper, plastic, cardboard, and food slop into energy; just to name a few. These initiatives team with universities and private-sector firms to develop solutions to deliver sources of renewable energy at forward locations.

The examples of energy efficiency cited thus far demonstrate how the structural complexity of forward-operating locations' energy requirements can leverage additive energy efficiencies to produce significant reductions in fuel requirements. With logistics consuming about half of DoD's personnel and a third of its budget,[21] the interactive savings of reduced force protection required to secure fuel convoys is infinitely more difficult to calculate,[22] but clearly reduces the combat-support tail and provides the JFC more operational flexibility to accomplish his mission.

Defense Acquisition Policy

Across the DoD, the potential to embrace operational energy metrics is less about saving money, although there is a large opportunity to do so; instead, it is more

about saving lives and fully realizing opportunities to achieve mission success with greater effectiveness.[23] Public Law directs the Secretary of Defense to employ a fuel efficiency Key Performance Parameter[24] (KPP) for both the "modification of existing or development of new fuel consuming systems."[25] The past eight years provide numerous operational-energy reports and studies by the Defense Science Board Energy Task Force, GAO, Rocky Mountain Institute, the Army Environmental Policy Institute, and Deloitte LLP to name a few; urging DoD to "wake-up and smell the coffee" with regards to the energy efficiency of weapons systems—DoD's lack of vision and leadership ultimately led Congress to require the Department's compliance by law.

In 2006, the Joint Requirements Oversight Council (JROC) recognized the value of energy efficiency in weapon-systems programs as evidenced by their KPP study recommendations to selectively apply an energy-efficiency KPP as necessary to major defense acquisition programs (MDAPs).[26] Included in the energy-efficiency KPP is the requirement to define the fully-burdened-cost of delivered fuel, to establish policy governing fuel efficiency in procurement decisions and the life-cycle cost analysis, to include the fully burdened cost of fuel (FBCF) during the analysis of alternatives (AoA) or evaluation of alternatives during the acquisition process.[27] The KPP study is the first step of many to come regarding energy efficiency across the acquisition system.

In Spring 2007, The Honorable Kenneth J. Krieg, Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)) wrote:

> Energy has emerged as a dominant factor in the 21st century battle space. Studies by the Institute for Defense Analyses, the Defense Science Board Task Force, the Energy Security Task Force, and JASONS[28] suggest that energy inefficiency is a significant liability, a constraint on operations, and a significant force protection challenge. After reviewing these studies, two conclusions become apparent.[29]

Mr. Krieg's two conclusions were that by reducing energy demand, operational forces are more flexible and less dependent on a logistics tail and second, that DoD acquisition processes undervalue energy efficiency technologies.[30] Mr. Krieg mandated a trade-off analysis[31] for the fully burdened cost of delivered energy for all tactical systems that generate a demand for energy, with the objective of improving energy efficiency of warfighting systems.

In the memorandum, Mr. Krieg included a pilot program for:

- Joint Light Tactical Vehicle
- Maritime Air and Missile Defense of Joint Forces alternative ship propulsion and efficiency options AoA
- Next-Generation Long-Range Strike concept decision[32]

The pilot programs are intended to develop the appropriate business practices to incorporate the fully burdened cost of energy into acquisition decisions—another step toward energy efficiency and operational flexibility.

Later in the spring of 2007, the Deputy Under Secretary of Defense for Logistics and Material Readiness (DUSD (L&MR)) established the mandatory warfighter material readiness / sustainment KPP.[33] This KPP consists of two Key System Attributes[34] (KSAs): material reliability and ownership cost. Ownership cost combines operations and support (O&S) cost with material-readiness considerations. The Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) includes unit operations energy (fuel, electricity, and petroleum products), maintenance, sustaining support, and continuing system improvements when computing ownership cost for weapons systems. O&S cost are an independent variable when considering Analysis of

Alternatives (AoA) and crucial when evaluating systems costs over the lifetime of a system.[35]

Whether Congress was dissatisfied with the pace of energy-efficiency acceptance in the DoD or the Department's rate of change, the 2009 Defense Authorization Act directed DoD to: develop energy efficiency policies, regulations, and directives; develop implementation plans requiring program managers to incorporate energy efficiency requirements into KPPs for military systems; and report to Congress on implementation plans. Additionally the Act directed DoD to: create an "Energy Czar" -- Director of Energy Plans and Programs; create a senior energy official in each service; and implement the FBCF into planning, capability, requirements development, and acquisition processes by October 14, 2011.[36]

Public Law obligated the Secretary of Defense to "require that the life-cycle cost analysis for new capabilities include the fully burdened cost of fuel during analysis of alternatives and evaluation of alternatives and acquisition program design trades"[37] earlier this year. The Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA (ALT)) thus directed program managers (PMs) to:

- Identify the strategy for improving energy productivity in the Technology Development Strategy.
- Identify the program's strategy for assessing energy productivity in the Acquisition Strategy.
- Ensure that the FBCF or an appropriate derivative is used in fuel- and energy-demand trade studies.

- Ensure that all systems engineering and support strategies include energy considerations using the FBCF methodologies.
- Ensure that the FBCF methodology is used in the estimation of the Ownership Cost Key System Attribute.[38]

The ASA (ALT) memorandum specifically detailed the methodology to compute the FBCF. This methodology includes the commodity price and direct cost of fuel, as well as the indirect cost of fuel such as operation and support cost, force protection, logistics forces, and specific platform cost.

The Joint Capabilities Integration and Development System (JCIDS) Manual (31 July 2009 update) addresses energy efficiency as a selectively applied KPP. Sponsors of systems must perform an analysis to determine if the energy efficiency KPP should be applied to the system. If the sponsor determines the KPP is not required, a summary of the justification will be provided in the capability development document (CDD) to the JROC.[39] The selective application of the energy efficiency KPP should not confuse the requirement for all Acquisition Category (ACAT) I programs involving materiel solutions and ACAT II and below programs as determined by the sponsor[40] to apply the sustainment KPP to the system. The availability KPP, reliability KSA, and ownership cost KSA construct the sustainment KPP. The ownership cost KSA requires the sponsor to incorporate the fully burdened cost of fuel analysis as part of the JCIDS review process.[41]

Fully Burdened Cost of Energy

Energy efficiency KPP metrics are sufficiently mature to begin large-scale implementation. On behalf of the Secretary of the Army, the Army Environmental Policy

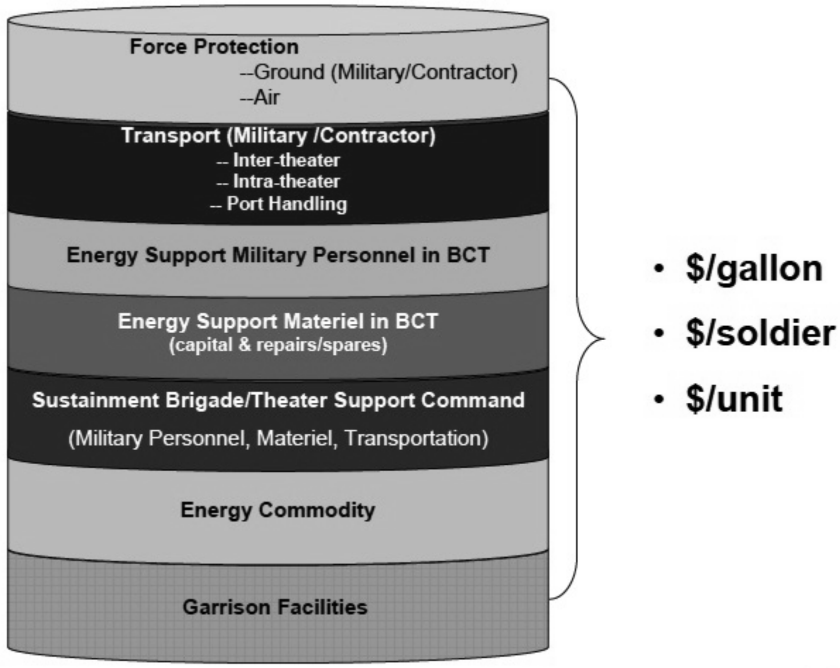


Figure 4. Sustain the Mission Project Cost Components

Institute (AEPI) developed analytical techniques to calculate the FBCF to generate data supporting the JROC sustainment KSA. The August 2007 Sustain the Mission Project 2 (SMP-II) continued the work of the original 2005 Sustain the Mission Project-I (SMP-I). SMP-I developed an analytic methodology for calculating the FBCF to sustain missions in operational theaters and in garrison training environments. SMP II developed a decision-support tool to calculate the FBCF using the SMP methodology and for evaluating energy-technology investments.[42]

Figure four summarizes the seven cost components that comprise the SMP-II tool extracted from the AEPI report.[43] The SMP-II components provide both in-theater and training base computations to sustain a Stryker Brigade Combat Team (SBCT). Derived from acceptable DoD standards, the components come from the: Force and Organization Cost Estimation System – Cost Factors Handbook; Operating and Support

Management Information System; the Multi-National Force-Iraq, Resource and Sustainment (MNF-I R&S) Food Advisor/ Oasis International Waters Inc; Product Manager, Petroleum and Water Systems (PM PAWS); DoD 2007 Facilities Pricing Guide for installation cost factors by Facility Analysis Category; and other, like-source pricing databases.[44]

The Army Environmental Policy Institute's analytical techniques calculated the FBCF, Jet Propellant 8 (JP 8) in this study, in a mature theater like Iraq, to be $14.13 per gallon.[45] In an immature theater, the cost of a gallon of fuel rises to $17.44[46] due mostly to longer resupply trips with associated increased force-protection requirements. This analytical tool provides an operational capability to senior leaders, making long-term procurement decisions with a greater level of fidelity concerning the cost-benefit analysis for systems lifetime cost of energy. Furthermore, it provides leaders the capability to factor the FBCF into wargame scenarios and when developing contingency plans. As mentioned previously, PL 110-417 requires the Secretary of Defense to assess alternative ways to improve energy efficiency in his tactical systems. The Army Environmental Policy Institute provides a suitable methodology to meet the spirit of this law and enables the Secretary to respond to Congress later this year, detailing the fully burdened cost of delivered energy for DoD weapons systems.

## Operational Effectiveness and Force Structure

What is operational effectiveness? The Joint Staff Manual governing the JCIDS process defines operational effectiveness as the following:

> Measure of the overall ability to accomplish a mission when used by representative personnel in the environment planned or expected for operational employment of the system considering organization, doctrine, supportability, survivability, vulnerability, and threat.[47]

Is this the right definition? How many times have you heard a pilot during a mission say, "I can't service that target or we have to RTB, we're BINGO-fuel[48]"? As General Ronald Keys, USAF (RET.) stated when discussing energy efficiency and mission effectiveness, "The basic question is: do I have enough fuel to get where I need to go, do my mission, and come back home?"[49] Stated another way, does my weapon system have the endurance to get to the objective and the persistence to accomplish the mission when there? Conventional thought would include the third portion of the question, get back home, but the culture-changing question is, what about accomplishing another mission or missions? Instead of current culture accepting system(s) limitations to our mission scenarios and planning, should the DoD more readily accept the physical limitations of our men and women as opposed to our weapon systems? When we remove fuel from the list of constraints to accomplish missions, then endurance and persistence will be the measures of people, not our weapons systems.

It is difficult not to argue that energy inefficiency reduces operational effectiveness by reducing combat power and increasing risk to combat-support personnel. The Center for Naval Analysis study, *Powering America's Defense: Energy and the Risks to National Security*, found the burdens of energy use at forward-operating bases present the most significant energy-related vulnerabilities to deployed forces, and reducing these energy requirements is their second priority recommendation for DoD to secure U.S. national security and long-term global stability.[50] Most recently, the 111th Congress made the finding that operational energy imposes significant logistical burdens and operational vulnerabilities on the warfighter.[51] Systems

endurance and persistence have more to do with operational effectiveness than with saving a few gallons of gas or “going green” in the DoD.

According to Andrew Bochman, founder and author of the DOD Energy Blog, when fuel efficiency factors into system design, procurement, and fielding, the cumulative effects will speed operations, expand maneuver and deployability, and free force structure to support combat by reducing the logistics tail.[52] Mr. Alan Shaffer, Principal Deputy Director of Defense Research and Engineering, echoed the thoughts of Mr. Bochman during his March 3, 2009 testimony before the House Armed Services Committee Subcommittee on Readiness, when he testified that as the Department’s energy posture improves, costs will drop, enabling sustained, uninterrupted operations while putting fewer service members in harm’s way.[53]

As previously noted, half of the forces in the field are supporting combat forces’ logistical requirements. These support forces constrain freedom of movement, increase risk, and divert combat forces to protect lines of communication.[54] An energy-efficient operational force provides the opportunity for significant impacts on force structure, risk reduction, and more options for the operational commander to accomplish his mission.

Weatherized living and work environments, more-efficient power generation and environmental control units, and smart power management provide the opportunity to reduce forward-operating base fuel requirements by upwards of eighty percent. This fuel savings could reduce the earlier cited example of 3,906 fuel tankers a month to supply fuel to generators on forward- operating bases to 781 fuel tankers a month. Instead of viewing this eighty percent reduction as a fuel savings, consider it as a considerable logistics manpower reduction. How much can the commander reduce his

Figure 5. Afghanistan Fuel Convoy

logistics personnel by? More importantly, can the commander increase his combat-to-combat support ratio above the current one-to-one ratio? Operating units not only could become un-tethered from supply bases, but could also employ more efficient weapons platforms, allowing them greater range of maneuver and reducing constraints on tactical planning.[55] Does three-to-one become the new combat-to-combat support Soldier ratio? Can Pentagon force structure planners reduce the joint force commander's lines of communication or 'tail' while providing more combat forces and fewer constraints?

We have seen that fully half of the casualties in combat theaters today come from convoy operations. With an eighty percent reduction in forward-operating-base fuel requirements for power generation alone, it stands to reason more energy-efficient systems have the potential to save a significant number of lives in future operations.

Energy-efficiency opponents state that systems need to be effective not efficient. This effectiveness red herring is debunked when one actually looks at the numbers. Certainly, from a defensive and core-competency perspective, logistics forces are not as well trained or as well equipped as combat forces. Reducing the number of logistics

forces in theater, as well as the number of convoys in our least protected vehicles will reduce the operational commander's risk, while concurrently enhancing his opportunity to be more effective.

Reduced support-force structure and reduced risk provide the joint force commander greater options. Continuing with the same, mandated force caps but with his greater combat-to-combat support force ratio provides the persistence needed to operate in the current counterinsurgency fight today as well as in the full-spectrum operations of the future. Greater endurance of weapons platforms removes major planning constraints and affords commanders the tactical endurance to perform multiple missions with greater operational flexibility, having broken the tether of the fuel tanker.

Second- and Third-Order Effects across the "Big A"

During the past eight years DoD's overseas contingency operations' use of energy significantly impacted the Defense Acquisition System, Joint Capabilities Integration and Development System, and the Planning, Programming, Budgeting, and Execution (PPBE) Process in the areas of law, policy, and culture. The Department can no longer ignore the logistics of delivered energy and assume the next supplemental appropriation will fund its overseas contingency costs to operate its warfighting systems.[56] The opportunity cost associated with Departmental resources is too vast to continue undervaluing the true cost of delivered fuel to its operational forces.

The Acquisition System is beginning to account for the fully burdened cost of delivered fuel as noted in the Defense Acquisition System Life Cycle Framework.[57] Opportunity still exists for acquisition executives and program executive officers to take

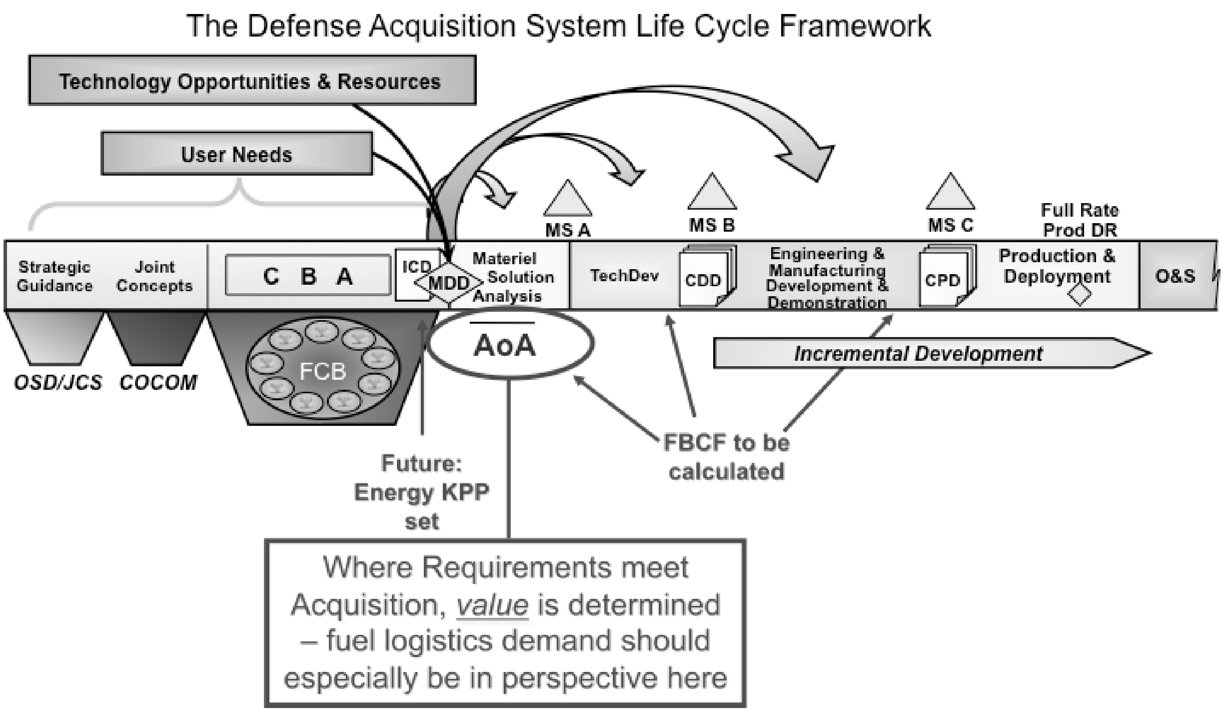


Figure 6. Energy KPP as part of AoA; FBCF calculated during Technology Development

a systems approach toward warfighting systems' energy consumption and efficiency by conducting analysis on portfolio capabilities and the program's role and support demands at milestone reviews.[58] When viewed as an opportunity cost, energy will reset equipment more efficiently, ensuring procurement of operations center tents considers the environmental control units and the generators that will manage their climates, and eventually shift a portion of the logistics "tail" to increase the size of the "tooth" DoD is able to bring to bear on current and future operations.

Systems are always important when operating an organization as large and complex as the DoD, but systems do not innovate; people do. Relationships may be a


Figure 7. DoD Decision Support Systems "Big A" Concept Map

critical piece to evolve the acquisition process. Only when the budget analyst, the logistical planner, and the program executive officer are working in concert within this large and complex acquisition system will transformational progress occur and mitigate DoD's energy problems. These relationships, coupled with sound policy, will move programs beyond single-program reviews to system-of-systems reviews that consider fuel demand requirements, looking down not only the individual stovepipes, but also looking across the multiple stovepipes of interdependent systems.

The Joint Capabilities Integration and Development System integrates the Congressional requirement to implement the fully burdened cost of fuel and energy efficiency into the analysis of alternatives. Additionally, energy-efficiency KPP language is updated, reflecting existing public law. The current, energy-efficiency KPP adds the logistical tail, in the form of fuel cost, to the speed/range/weight trade space of program decisions. To this end, the Joint Staff J-4 is conducting a study to determine the appropriate methodology for energy efficiency KPP implementation and analysis.

Service and joint-force planning continues to remain an opportunity to improve force effectiveness. Today, wargames do not account for the risk of delivered fuel to the

warfighter. Permitting enemy forces to threaten friendly logistics more realistically than planners' account for this threat today by integrating convoys, tankers, and oilers into the "at risk" part of the operational environment will build the required risk into future joint force design decisions. By incorporating fuel delivery, protection, and vulnerability risk into service and joint-campaign models, major wargames, defense planning scenarios, and force build-outs; the Department will more accurately value forces with additional unrefueled range and loiter time as well as smaller logistics tails.[59]

With energy fully considered in force planning and campaign design, the cost to deliver fuel over the life of a system considering service- and joint-campaign models, wargames, and scenario builds becomes feasible in the JCIDS trade-space. Fully valuing energy enables the option to mandate descriptions how material solutions' fuel-demand impacts the operational capability of interdependent systems.[60] With Joint Staff established metrics to reduce the fuel-delivery-tail, force structure can begin to transition away from the tail and toward the proverbial pointed-end of the spear.

The former USD (AT&L), John J. Young, Jr. declared implementation of life cycle management a top priority for the Department of Defense.[61] One of the means to this end was to align resources to readiness in a cooperative pilot program with the DoD Comptroller and the Director, Cost Assessment and Program Evaluation to determine the feasibility of annually assessing the attainment of life cycle metrics as part of the Planning, Programming, Budgeting, and Execution (PPBE) Process.[62] A joint memorandum from DUSD (L&MR) and Director, Acquisition Resources and Analysis to Military Department Secretaries and Acquisition Executives reinforced the USD (AT&L) directive with the implementation of the life-cycle sustainment-outcome metrics data

reporting.[63] These initiatives provide the enterprise visibility to Acquisition program information. The consolidated, information system provides cost by program, mission description, funding, and schedule.

The information system is web-based, which affords the prospect to enact several of the recommendations previously annotated. Of immediate interest is viewing weapon systems through the lens of interdependent energy requirements. A tool similar to this provides the required fidelity for senior leaders to make educated decisions on programming and execution, when presented interdependent, energy-cost, and risk-burdened pictures for analysis. The shared view of the acquisition process and the PPBES interplay is essential to comply with USD (AL&T) Directive-Type Memorandum 09-027 – Implementation of the Weapon Systems Acquisition Reform Act of 2009, which complies with P.L. 111-23,[64] to accomplish cost estimates, analysis, and certification of weapons systems.

## Conclusion

Properly applied, operational-energy metrics can increase operational flexibility for the JFC. Operational-energy metrics are sufficiently mature for the Chairman of the Joint Chiefs of Staff to mandate their use as a key performance parameter for all acquisition programs and new increments of fuel-consuming systems. The sooner practices and culture in the Department of Defense change to fully value the delivered cost of fuel, the sooner joint force commanders will reap the “strategic benefits of reallocating “tail” personnel, force structure, and investment to “tooth” by reducing users’ need”[65] to conduct logistics operations and secure fuel convoys. A first step for the department should be to include fuel delivery, protection, and vulnerability risk into

Service & Joint campaign design, wargames, defense planning scenarios, and force planning builds.

Considering system interdependencies as they relate to overall fuel requirements, theater fuel-transportation deliveries to operational bases can be significantly reduced by implementing current program manager acquisition programs as new equipment fielding or as part of reset to rotating units. Systems such as the Advanced Medium Mobile Power Sources, modern environmental control units, or simply applying foam to tents are ready to enter today's fight as well as tomorrow's.

With significant reduction in theater fuel requirements, the potential influence on operational effectiveness and force structure is promising. Fewer logistics personnel required to deliver fuel present the opportunity to increase combat force structure, while simultaneously reducing the risk associated with fuel-convoy operations. Reducing fuel requirements is less about making the Department ”green” and more about increasing operational flexibility, increasing combat force structure, and reducing risk.

The second- and third-order effects across the three systems of "Big A" acquisition provide the Department the prospect of seizing the opportunity cost to reset equipment more efficiently, shift a portion of the logistics tail to increase combat force structure, and improve force effectiveness. By taking a Department-wide systems viewpoint as it relates to energy interdependencies of weapons systems, and embracing the fully burdened cost of fuel, future programs will benefit from incremental upgrades to weapons systems with current technology as an alternative to systems incremental upgrades. More-efficient weapons systems will provide the Department the strategic option of increasing its combat to combat-support ratio—putting more combat forces on

the ground resulting from reduced logistics requirements. These same efficient weapons systems will provide the operational commander the added flexibility to loiter longer or strike deeper, breaking the tether of the air- and ground-tankers.

Endnotes

[1] Admiral Michael G. Mullen, USN Chairman of the Joint Chiefs of Staff Posture Statement presented to the 111th Congress Senate Committee on Armed Services, (Washington, DC: May 5, 2009), 15.

[2] Jerry Warner and P.W. Singer, "Fueling the "Balance": A Defense Energy Strategy Primer," *Brookings Foreign Policy Paper Series No. 17*, August 2009, http://www.brookings.edu/papers/2009/08_defense_strategy_singer.aspx (accessed October 27, 2009).

[3] U.S. Government Accountability Office, Defense Management: DOD Needs to Increase Attention on Fuel Demand Management at Forward-Deployed Locations (Washington, DC: U.S. Government Accountability Office, February 2009), 7.

[4] The U.S. Army uses several variants of fuel transport vehicles; M1062 7,500-gallon tankers, 9,000-, 8,000-, and 7,500-gallon commercial tankers, and 2,500- and 5,000-gallon tactical fuel tankers. For the purpose of this paper, 8,000-gallon fuel tankers are used to normalize the comparison of fuel delivery requirements to forward operating locations. Furthermore, these 8,000-gallon tankers will be assumed full when delivered to forward fuel transfer points—there in no intent to investigate the widely know issues surrounding fuel theft in Iraq and Afghanistan.

[5] Theater refers to the U.S. Central Command's Area of Operations.

[6] Chris Dipetto, "Defense Department Energy Posture," Congressional Record (March 13, 2008): D301.

[7] Testimony of John Young and Philip Grone before the Subcommittees on Terrorism, Unconventional Threats and Capabilities and Readiness of the House Armed Services Committee, September 26, 2006.

[8] Office of the Under Secretary of Defense For Acquisition, Technology, and Logistics, Report of the Defense Science Board Task Force: DoD Energy Strategy, "More Fight—Less Fuel" (Washington, DC: OUSD (AT&L), February 2008), 23.

[9] Ibid., 44.

[10] Bochman, A.. 2009. Measure, Manage, Win: THE CASE FOR OPERATIONAL ENERGY METRICS. Joint Force Quarterly: JFQ, October 1, 113-119. http://www.proquest.com.ezproxy.usawcpubs.org/ (accessed October 27, 2009).

[11] “DoD Energy Security Task Force,” 2008, linked from *The United States Department of Defense Research and Engineering Hope page* at, http://www.dod.mil/ddre/doc/DoD_Energy_Security_Task_Force.pdf (accessed .December 12, 2009).

[12] U.S. Government Accountability Office, Defense Management: Increased Attention on Fuel Demand Management at DOD’s Forward-Deployed Locations Could Reduce Operational Risks and Costs (Washington, DC: U.S. Government Accountability Office, March 2009), 3.

[13] Ibid., 3.

[14] Testimony of Alan R. Shaffer before the Subcommittee on Readiness of the House Armed Services Committee, March 3, 2009.

[15] Alan E. Haggerty, “S&T and Maneuver Warfare: A Current Success and a Future Challenge,” July 29, 2008, http://www.dtic.mil/ndia/2008maneuver/Haggerty.pdf (accessed December 13, 2009).

[16] GAO: DOD Needs to Increase Attention on Fuel Demand Management at Forward-Deployed Locations, 14.

[17] Oak Ridge National Laboratory, “DEVELOPMENT OF PROOF-OFCONCEPT UNITS FOR THE ADVANCED MEDIUM-SIZED MOBILE POWER SOURCES (AMMPS) PROGRAM,” March 2002, http://www.pm-mep.army.mil/pdffiles/ORNLReport2.pdf (accessed December 13, 2009).

[18] GAO: Increased Attention on Fuel Demand Management at DOD’s Forward-Deployed Locations Could Reduce Operational Risks and Costs, 3.

[19] OUSD (AT&L), “Department of Defense Report to Congress on Energy Security Initiatives,” October 2008, http://www.dod.mil/ddre/doc/Oct08_ESTF_Semi-Annual_Report_to_Congress.pdf (accessed December 7, 2009).

[20] Haggerty, “S&T and Maneuver Warfare: A Current Success and a Future Challenge,” 15.

[21] Ibid., 14.

[22] Major Vincent C. Nwafor’s article *The Changing Face of Fuel Management* in the March-April 2007 Army Logistician, http://www.almc.army.mil/alog/issues/Mar-Apr07/pdf/mar_apr2007.pdf, provides insight into both the complexity and fluidity of combat logistics patrols.

[23] Bochman, “Measure, Manage, Win: THE CASE FOR OPERATIONAL ENERGY METRICS,” 115.

[24] Those attributes or characteristics of a system that are considered critical or essential to the development of an effective military capability. A KPP normally has a threshold, representing the required value, and an objective, representing the desired value. KPPs are contained in the Capability Development Document (CDD) and the Capability Production Document (CPD) and are included verbatim in the Acquisition Program Baseline (APB). Certain KPPs may be “mandatory” or “selectively applied,” depending on the system. See Validation

Authority, Capability Development Document, Capability Production Document, Mandatory Key Performance Parameters (KPPs), Selectively Applied KPPs, threshold value, objective value, and Joint Potential Designator, https://acquipedia.dau.mil/default.aspx, ACQuipedia, Defense Acquisition University.

[25] *National Defense Authorization Act*, Public Law 417, 110th Cong., 1st sess. (October 14, 2008), Sec 332.

[26] Vice Chairman of the Joint Chiefs of Staff Admiral E. P. Giambastiani, "Key Performance Parameter Study Recommendations and Implementation memorandum for Secretaries of the Military Departments, Washington, DC, 17 AUG 2006.

[27] Ibid., 4.

[28] JASON is an independent group of scientists, which advises the United States Government on matters of science and technology. The group was first created as a way to get a younger generation of scientists — that is, not the older Los Alamos and MIT Radiation Laboratory alumni — involved in advising the government. It was established in 1960 and has somewhere between 30 and 60 members. For administrative purposes, JASON's activities are run through the MITRE Corporation, a non-profit corporation in McLean, Virginia, which contracts with the Defense Department. The name "JASON" is sometimes explained as an acronym, standing either for "July-August-September-October-November," the months in which the group would typically meet; or, tongue in cheek, for "Junior Achiever, Somewhat Older Now." However, neither explanation is correct; in fact, the name is not an acronym at all. It is a reference to Jason, a character from Greek mythology. The wife of one of the founders (Mildred Goldberger) thought the name given by the defense department, Project Sunrise, was unimaginative and suggested the group be named for the Greek mythological hero Jason. *WikipediA, The Free Encyclopedia*, http://en.wikipedia.org/wiki/JASON_(advisory_group) (accessed February 15, 2010).

[29] Under Secretary of Defense (Acquisition, Technology, & Logistics), "Fully Burdened Cost of Fuel Pilot Program," memorandum for Under Secretaries of Defense, Service Acquisition Executives, & Joint Staff, Washington, DC, April 10, 2007.

[30] Ibid., 1.

[31] Selection among alternatives with the intent to obtain the optimal, achievable system configuration. Often a decision is made to opt for less of one parameter in order to achieve a more favorable overall system result.

[32] USD (AT&L) "Fully Burdened Cost of Fuel Pilot Program," 2.

[33] Deputy Under Secretary of Defense for Logistics and Material Readiness, "Life Cycle Sustainment Outcome Metrics," memorandum for Under Secretaries of the Military Departments, Washington, DC, March 10, 2007.

[34] KSAs are those system attributes considered critical or essential for an effective military capability but not selected as KPPs. KSAs provide decision makers with an additional level of capability prioritization below the KPP but with senior sponsor leadership control (generally 4-star level, Defense agency commander, or Principal Staff Assistant). In the case of the

mandated Sustainment KPP, the supporting KSAs are inserted verbatim into the acquisition program baseline (APB). Any changes to these KSAs will be documented in subsequent updates to the APB. The number of KSAs (beyond those supporting the Sustainment KPP) should be kept to a minimum to maintain program flexibility. KSAs do not apply to the net-ready KPP (NR-KPP). U.S. Joint Chiefs of Staff, Manual for the Operation of the Joint Capabilities Integration and Development System, replaces the cancelled CJCSM 3170.01C (Washington, DC: U.S. Department of the Army, February 2009 with 31 July 2009), B-2.

[35] Cost Analysis Improvement Group, “Operating and Support Cost-Estimating Guide,” October 2007, http://dcarc.pae.osd.mil/reference/osd_ces/O_S_Cost_Estimating_ Guide_Oct_2007.pdf (accessed December 20, 2009).

[36] P.L. 110-417, SEC. 332.

[37] Ibid.

[38] Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) “Energy Productivity in U.S. Army Weapon Systems”, memorandum for Assistant Secretaries of the Army, Washington, DC, January 7, 2009.

[39] U.S. Joint Chiefs of Staff, *Manual for the Operation of the Joint Capabilities Integration and Development System*, (Washington, DC, February 2009 updated July 31, 2009), B-5.

[40] Ibid., B-B-1.

[41] Ibid., B-B-4.

[42] Army Environmental Policy Institute, “Sustain the Mission Project: Energy and Water Costing Methodology and Decision Support Tool,” July 2008, http://www.aepi.army.mil/internet/ SMP%202%20Final%20Technical%20Report.pdf (accessed December 5, 2009).

[43] Ibid., 3.

[44] Ibid., 4.

[45] Ibid., 14.

[46] Ibid., 14.

[47] U.S. Joint Chiefs of Staff, *Manual for the Operation of the Joint Capabilities Integration and Development System*, GL-17.

[48] RTB: return to base; BINOG-fuel: A prescribed minimum amount of fuel for an aircraft that enables a safe return to the intended landing field for a given mission.

[49] CAN, “Powering America’s Defense: Energy and the Risks to National Security,” May 2009, http://www.cna.org/documents/PoweringAmericasDefense.pdf (accessed December 30, 2009).

[50] Ibid., 45.

[51] National Defense Authorization Act of Fiscal Year 2010, Public Law 288, 111th Cong., 1st sess. (October 28, 2009), Sec 903.

[52] Bochman, "Measure, Manage, Win: THE CASE FOR OPERATIONAL ENERGY METRICS," 117.

[53] Shaffer testimony to HASC, 1-17.

[54] Report of the Defense Science Board Task Force: DoD Energy Strategy, "More Fight—Less Fuel," 17.

[55] Center for Advanced Defense Studies, "Defense Industry Energy Reform: Incentives and Capabilities," September 25, 2009, http://www.c4ads.org/files/DOD%20Energy%20Reform.pdf (accessed December 30, 2009).

[56] Office of the Deputy Under Secretary of Defense Acquisition and Technology, "DoD Energy Demand: Addressing the Unintended Consequences," September 2008, http://www.acq.osd.mil/sse/briefs/20080912-ODUSD-AT-Energy-Demand-Brief-DiPetto.pdf (accessed October 27, 2009).

[57] OUSD(AT&L)/Energy, "Energy & Military Effectiveness: Changing How Energy is Considered in DoD Planning and Acquisition," November 30, 2009, http://publish.ndia.org/Divisions/Divisions/EnvironmentAndEnergy/Documents/Content/ContentGroups/Divisions1/Environment/PDFs31/2.DiPetto%20Energy%20Brief.pdf (accessed December 12, 2009).

[58] Ibid., 24.

[59] Ibid., 16.

[60] ODUSD (AT&L), "DoD Energy Demand: Addressing the Unintended Consequences," September 2008, http://www.acq.osd.mil/sse/briefs/20080912-ODUSD-AT-Energy-Demand-Brief-DiPetto.pdf (accessed October 27, 2009).

[61] USD (AT&L), "Implementing a Life Cycle Management Framework," memorandum for Secretaries of the Military Services, Washington, DC, July 31, 2008.

[62] Ibid.

[63] DUSD(L&MR) memo December 11, 2008, Implementation of Life Cycle Sustainment Outcome Metrics Data Reporting.

[64] USD (AT&L) "Directive-Type Memorandum (DTM) 09-027 – Implementation of the Weapon systems Acquisition Reform Act of 2009," memorandum for Secretaries of the Military Departments, CJCS, Under Secretaries of Defense, Washington, DC, December 4, 2009.

[65] ODUSD (AT&L), "DoD Energy Demand: Addressing the Unintended Consequences," 13.